SEVENTH ANNUAL REPORT

OF

Rutgers Scientific School,

FOR THE YEAR 1871.

TRENTON, N. J.:
PRINTED AT THE STATE GAZETTE OFFICE.

1872.

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REPORT OF THE TRUSTEES.

To His Excellency Theodore F. Randolph, Governor of the State of New Jersey:

SIR:—I beg leave, in behalf of the Trustees of Rutgers College, to submit the seventh annual report of Rutgers Scientific School, in accordance with the requirements of the fourth paragraph of section fifth of the act of Congress approved July 2, 1862, and section fifth of the act of the Legislature of the State of New Jersey, approved April 4, 1864.

Since the date of the last annual report, several changes have been made in the organization and equipment of the Scientific School, the most important of which will be more particularly noticed under their appropriate heads.

I. FACULTY OF RUTGERS SCIENTIFIC SCHOOL.

The Faculty is now constituted as follows:

Rev. William Henry Campbell, D. D., LL. D., President, and Professor of Moral Philosophy.

George H. Cook, Ph. D., LL. D., Vice President, and Professor of Chemistry, Natural History and Agriculture.

David Murray, A. M., Ph. D., Professor of Mathematics, Natural Philosophy and Astronomy.

Rev. Theodore S. Doolittle, Professor of Rhetoric, Logic and Mental Philosophy.

John Conover Smock, A. M., Professor of Mining and Metallurgy

George W. Atherton, A. M., Voorhees Professor of History Political Economy and Constitutional law, and Military Superintendent.

Rev. Carl Meyer, D. D., Professor of French and German.

Francis Cuyler Van Dyck, A. M., Professor of Analytical Chemistry.

Edward A. Bowser, M. S., Professor of Mathematics and Engineering.

Isaac E. Hasbrouck, A. M., Tutor in Mathematics.

Since the last report was made, Professor George H. Cook has returned from Europe, where he had spent several months in making

observations directly connected with the work of the Agricultural College and the State Geological Survey. His investigations respecting the condition of scientific education and industries in England, and many of the principal countries on the continent, are highly interesting and important, and cannot fail to render useful service to the advancement of those interests in the State of New Jersey.

Colonel Kellogg, who had for five years filled the positions of Professor of Military Engineering and Military Superintendent, resigned at the close of the summer term, to engage in other pursuits. The duties of his Professorship have been assigned to Professor Bowser, who was at the last Commencement promoted to a full Professorship; and the duties of the Military Superintendency to Professor Atherton.

Professor Van Dyck has returned from Europe, and assumed the duties of his chair.

II. COURSE OF STUDY.

The Scientific School provides two principal Courses of Study, either of which the student may elect for himself:

1. A COURSE IN CIVIL ENGINEERING AND MATHEMATICS.
2. A COURSE IN CHEMISTRY AND AGRICULTURE.

These courses now extend through four years. The studies of the first two years are the same in both, and are arranged with particular reference to the wants of those who desire, within a limited time, to prepare themselves as land surveyors, or practical workers in any department of industry.

A shorter SPECIAL COURSE IN CHEMISTRY, extending through only two years, is also provided to meet the wants of such students as wish to devote themselves exclusively to that branch.

In addition to these regular courses, provision is made for PARTIAL STUDENTS, who may enter at any time, and select, under the direction and advice of the Faculty, such studies as they may be found qualified to pursue with classes already formed, subject to the general regulations and discipline of the Institution, and to such examinations as may be prescribed in each case. Such students, on leaving the Institution, receive certificates stating the studies pursued and the attainments made. Students completing either of the four years' courses, receive the degree of Bachelor of Science.

III. TERMS OF ADMISSION.

Applicants for admission to the full courses of study must be sixteen years of age, and of good moral character, and must pass a satisfactory examination in English Grammar and Spelling, Geography, Physical Geography, History of the United States, Arithmetic, Algebra to Equations of the Second Degree, and three books of Plane

Geometry. The regular examinations for admission are held on the Saturday, Monday and Tuesday preceding the Annual Commencement, and on the day preceding the opening of the fall term. Candidates for advanced standing are examined, in addition to the preparatory studies, in those already pursued by the class they propose to enter.

IV. STUDENTS AND STUDIES.

The classes now in the institution are:

First—The class organized in September, 1869, which will be graduated in June, 1872.

Second—The class organized in September, 1870, which will be graduated in 1873.

Third—An intermediate class organized in September, 1871, which will be graduated in 1874.

Fourth—The class organized in September, 1871, which will be graduated in 1875, and is the first regular class in the new four years' course.

The class mentioned as an intermediate one, is made up of young men far enough advanced to enter upon the studies of the second year of the new four years' course, but not of the three years' course. The arrangement thus made will give us a very small graduating class in 1874, when, otherwise, there would have been none.

The first class now consists of thirteen students; the second of fourteen; the third of three; and the fourth of twenty-two, making a total of fifty-two now in attendance.

There have been in the institution during the year, including the last graduating class, seventy students, of whom thirteen were from the State of New York; two from Japan, and the remaining fifty-five from the State of New Jersey, representing the counties as follows:

Bergen	2
Cumberland	2
Essex	7
Gloucester	1
Hudson	4
Hunterdon	1
Mercer	1
Middlesex	14
Monmouth	3
Morris	5
Ocean	1
Somerset	5
Union	10

The classes are now designated, to correspond with those in the Classical department, Senior Scientific, Junior Scientific, Sophomore Scientific, and Freshman Scientific.

The new course of study is given in full, in the appendix to this report. The general scheme does not greatly differ from that pursued by students now in the institution; but it has been enlarged and more carefully graded, with the design of furnishing, in connection with the usual amount of technical studies, a considerable addition of those that have value chiefly as a means of mental training.

There seems no room to doubt that important benefits will result from the change. More time is allowed for field and laboratory practice; the proportion of studies throughout the course is better preserved, and the way is open for a fair trial of the question—how far the scientific, or, as it is sometimes called, the "new education," can be made equivalent *as an education*, and not merely as a means of gaining a livelihood, to the older classical system? The State Board of Visitors, the Trustees of the College, and the Faculty, are fully impressed with the importance of this aspect of the problem, and are bending their best energies to the practical solution of it.

A very serious disadvantage, under which students in the Scientific School labor, and one which must, at present, greatly affect results, is the fact that their preparatory training is far less thorough and extended than that of classical students.

It is obvious that this fact must exert its influence upon the entire course of study in each department, and prevent, as long as it exists, any satisfactory comparison of the two. The only ways that readily suggest themselves in which the difficulty can be overcome, are to make the standard of admission to the Scientific Department still higher than at present; or, to lengthen the courses of study; or, to organize post-graduate courses for the benefit of such as may wish to pursue advanced special studies. The first of these seems, at present, to offer the fewest difficulties; and while no great increase in the requirements for admission is immediately proposed, it is desirable to keep fully in view the fact, that scientific education can never become all that we hope to see it until it is placed, in this respect, upon an equal footing with classical education. The additional requirement for admission, that is of most immediate importance, is a knowledge of the elements of the Latin language. Some scientific schools in the country have already adopted it, and all feel the need of it, if not as a means of mental discipline, yet as a key to the knowledge and use of scientific terms. It is hoped that the operation of the new free school law, passed last winter by the State Legislature, with such modifications of it as experience may suggest, will so far improve the condition of the public schools as to justify us in expecting better preparations in the pupils they send us.

One of the features of our instruction upon which we look with particular satisfaction, is the large amount of practice that students receive in the field and laboratory. Professors Murray, Bowser, and Van Dyck, and Mr. Hasbrouck, have devoted unusual time and labor

to this work in their respective departments; and it is believed that no student using ordinary diligence can now go through his course here, without acquiring a competent and available knowledge of the practical work of surveying, engineering, and analyzing. In the department of the English language and literature, also, Professor Doolittle is bestowing great attention upon practical exercise in writing and speaking, with very gratifying results.

The class that entered at the beginning of the present academic year is, with a single exception, larger than any previous one, and represents a larger portion of the State than any other has ever done. Eight counties, however, are still unrepresented, as will be seen from the table above. It is hoped that the attention of the County Superintendents of schools, on whose recommendation the State scholarships are filled, may be called to the importance of having their young men avail themselves of the privileges here gratuitously offered them by the State.

V. THE LAST GRADUATING CLASS.

At the last commencement of the College, in June, 1871, the graduating class, consisting of nine members, was admitted to the degree of Bachelor of Science. Theses were prepared by them, and read before the State Board of Visitors, on the following subjects:

James Kennedy Barton, New York City, "The requirements of the civil engineer."

Stephen George Gano, Centreville, N. J., "The iron bridge over the Harlem river."

Winfield Scott Lasher, Germantown, N. Y., "The bridge over the Hudson, at Albany."

Charles William Merritt, Piscataway, N. J., "The mining operations at Hell Gate."

John Anderson Miller, Jr., Newark, N. J., "The iron railroad bridge at Newark."

Charles Lansing Pruyn, Albany, N. Y., "The foundations of the new capitol, at Albany."

Otis Comfort Tiffany, Newark, N. J., "The caisson of the East River bridge."

Joseph Ward, Jr., Newark, N. J., "The Newark water works."

Silas Ebenezer Weir, Jr., New Brunswick, N. J., "The Fairmount water works, at Philadelphia."

The two prizes offered by the Professor of Mathematics for the best theses, were awarded:—the first to Mr. Gano, the second to Mr. Miller.

A prize of one hundred species of minerals, offered by the Professor of Chemistry to the member of the graduating classes who should be able to identify and name the largest number of them, was awarded to Mr. Barton.

The members of the class, as far as heard from, have found ready

openings to good situations, and most, if not all of them, are now engaged either in special studies or in their chosen occupations, as manufacturers, engineers, &c.

VI. MILITARY DEPARTMENT.

In this department we have endeavored to comply faithfully with the laws of Congress and of this State. Besides the instruction given to the graduating class in military engineering and field fortifications, the members of all the classes are drilled by the Military Superintendent, in the autumn and summer terms, in infantry tactics, including the manual of arms. The arms and accoutrements furnished by the State for this purpose are properly cared for in the armory provided by the trustees, and are now in good condition. In the new Geological Hall, now building, arrangements are made for a large drill room, suitable for use at all seasons of the year, which will put the department upon a better footing than ever before.

VII. AGRICULTURAL DEPARTMENT.

A full report of the condition and operations of this department will be furnished by Dr. Cook. The experimental farm, which the trustees are required, by the law of the State, to carry on, in connection with the agricultural department, has been, from the first, a heavy charge to the funds of the College. But, under Dr. Cook's judicious management, it is becoming, each year, more nearly self-supporting, and is a striking illustration of the results of scientific culture. When it came into the possession of the trustees, it was "run out" and almost worthless for purposes of cultivation; but thorough tillage, under-draining, and the free application of fertilizers, are rapidly bringing these barren acres to a high state of fertility. The crops are, each year, more abundant and less subject to the accidents of unfavorable seasons.

VIII. IMPROVEMENTS IN BUILDINGS, ETC.

The steady increase in the number of instructors and of students for several years past, has rendered it absolutely necessary to provide additional buildings. The trustees are now erecting a Geological Hall, which will contain rooms for a Geological Museum, for recitations, for military drill, and for the general uses of the scientific and agricultural departments.

It is expected to be completed and ready for use before the end of the present academic year. By the liberality of a few generous friends, including the Governor of the State, the trustees were enabled to build of stone instead of brick, as was first intended; and while the change of material has occasioned some delay in the

progress of the building, it gives us a structure more suitable for the purposes to which it is to be devoted, and more worthy of the State, with whose interests it is closely connected.

The amount received from the State Treasury, for the fiscal year ending October 31st, 1871, is six thousand nine hundred and sixty dollars, ($6,960), which has been expended exclusively for the salaries of the Professors in the Scientific School.

All which is respectfully submitted.

WM. H. CAMPBELL,

President of the Board of Trustees.

New Brunswick, N. J., Nov. 15, 1871.

APPENDIX.

APPENDIX A.

COURSES OF STUDY.

I. COURSE IN CIVIL ENGINEERING AND MECHANICS.

FRESHMAN YEAR.

First Term.

1. French.
2. Mathematics—Loomis' Algebra, from Quadratic Equations.
3. Physiology—Dalton's.
4. Rhetoric—Haven's. Composition and Declamation.
5. Draughting—Construction of Problems.

Second Term.

1. French.
2. Mathematics—Loomis' Geometry, from Book IV.
3. Zoology—Agassiz and Gould's.
4. Elocution—Lectures, Composition and Declamation.
5. English Literature—Shaw's Manual.
6. Draughting.

Third Term.

1. French.
2. Mathematics—Loomis' Trigonometry, Plain and Spherical.
3. Botany.
4. English Literature—Shaw's Manual.
5. Draughting. Composition and Declamation.

General exercises during the year in Composition and Declamation. Bible Class on the Sabbath.

SOPHOMORE YEAR.

First Term.

1. Descriptive Geometry and Surveying.
2. Chemistry—Lectures.

3. Mental Philosophy—Haven's. Composition and Declamation.
4. Modern History—Weber's Outlines.

Second Term.

1. Descriptive Geometry and Road Making—Gillespie's.
2. Chemistry—Lectures.
3. Mental Philosophy—Haven's. Composition and Declamation.
4. Modern History—Weber's Outlines.

Third Term.

1. Leveling and Railroad Curves—Henck's Field Book. Field Practice.
2. Shades, Shadows and Perspective.
3. Chemistry—Lectures.
4. Mental Philosophy—Lectures. Composition and Declamation.
5. Creasy's Constitutional History of England.

General exercises during the year in Composition and Declamation. Bible Class on the Sabbath.

JUNIOR YEAR.

First Term.

1. German.
2. Analytical Geometry—Church's.
3. Natural History—Silliman's Physics.
4. History of Civilization—Guizot's; and Constitutional History of the United States—Lectures.

Second Term.

1. German.
2. Calculus.
3. Natural History—Silliman's Physics.
4. Political Economy and Constitutional History of the United States.

Third Term.

1. German.
2. Analytical Mechanics—Bartlett's.
3. Astronomy—Lockyer's.
4. International Law—Woolsey's.

General exercises during the year in Composition and Original Declamation. Bible Class on the Sabbath.

SENIOR YEAR.

First Term.

1. Analytical Mechanics—Bartlett's.
2. Geodesy—Theory and Practice of Triangulation.
3. Chemistry—Lectures.
4. Moral Philosophy.

Second Term.

1. Civil Engineering—Mahan's.
2. Geodesy: Practical Astronomy; Indeterminate Analysis.
3. Chemical Physics—Lectures.
4. Moral Philosophy.

Third Term.

1. Civil Engineering—Mahan's. Railway Practice.
2. Architecture—Lectures.
3. Geology—Lectures.
4. Moral Philosophy.

General exercises during the year in Composition and Original Declamation. Bible Class on the Sabbath.

II. COURSE IN CHEMISTRY AND AGRICULTURE.

[First two years the same as in Civil Engineering and Mathematics.]

JUNIOR YEAR.

First Term.

1. German.
2. Analytical Geometry—Church's.
3. Natural History—Silliman's Physics.
4. History of Civilization—Guizot's; and Constitutional History of the United States—Lectures.

Second Term.

1. German.
2. Analytical Chemistry, with Laboratory Practice.
3. Physics and General Chemistry—Lectures on Agriculture.
4. Political Economy and Constitutional History of the United States.

Third Term.

1. German.
2. Analytical Chemistry, with Laboratory Practice.
3. Vegetable Physiology.
4. International Law—Woolsey's.

General exercises during the year, in Composition and Original Declamation. Bible Class on the Sabbath.

SENIOR YEAR.

First Term.

1. Mining and Metallurgy.
2. Geodesy.
3. Chemistry and Principles of Agriculture—Farm Accounts.
4. Moral Philosophy.

Second Term.

1. Agriculture—its methods and products.
2. Geodesy and Practical Astronomy.
3. Chemical Physics—Lectures. Laboratory Practice.
4. Moral Philosophy.

Third Term.

1. Animal Physiology.
2. Architecture—Lectures.
3. Geology—Lectures.
4. Moral Philosophy.

General exercises during the year in Composition and Original Declamation. Bible Class on the Sabbath.

III. SPECIAL COURSE IN CHEMISTRY.

FIRST YEAR.

First Term.

1. Elements of Chemistry—Text Book and Lectures.
2. Blow-pipe Analysis.
3. Elements of Mineralogy.

Second Term.

1. Physics and Chemistry—Text Book and Lectures.
2. Chemical Analysis—Qualitative.

Third Term.

1. Chemical Analysis—Qualitative and Quantitative.
2. Vegetable Physiology.

SECOND YEAR.

First Term.

1. Chemical Analysis—Analysis of Minerals, Ores, &c.
2. Mineralogy—Determinative.

Second Term.

1. Chemical Physics—Heat, Electricity, Magnetism, Galvanism and Electro-Magnetism. Text Book and Lectures.
2. Analysis of Fertilizers and Chemical Products.

Third Term.

1. Lectures on Geology.
2. Chemical Analysis—Special Investigations.

APPENDIX B.

ANNUAL LECTURE FOR 1871.

By PROF. G. H. COOK.

ON AGRICULTURE AS SEEN IN EUROPE, IN 1870.

New Jersey agriculture is in a prosperous condition. With the stimulus of convenient and large markets—ever ready to take all the farmer has to sell—with cheap and abundant means of enriching the ground, and with a soil that most generously responds to every attempt at its improvement, our farmers should prosper and our farms should improve. Of the great staples of the United States, corn and wheat, our annual product is very large, almost enough for the wants of our large population in towns, and the average crops per acre are quite as large as any in the Union, and much above the average, and even above the average of the richest new States. The amount of our live stock is large and of the best quality. And we find ready sale for enormous crops of vegetables and heavy market products, which cannot be profitably brought from more remote States.

This condition of our agriculture is of recent date. Our soils have been exhausted and so much of them abandoned, that the State has been a by-word for its poverty. The improvement has come from the free use of fertilizers, and more careful cultivation of the soil. Green sand marl in the middle and southwestern counties, and lime and plaster in those more to the north have been the foundation of all the improvements.

At no period of its history has agricultural progress been more rapid in the State than it is now, and its promise for the future is most encouraging.

My official connection with the State Agricultural College, as well as my personal tastes, have led me to take active interest in the development of our resources, and the improvement of our methods of farming. By the favor of the trustees of Rutgers College, and of my associates in the faculty, I was allowed to leave my duties at home last year and spend several months in Europe. During the time I was abroad I traveled in England, Scotland, Norway, Sweden, Denmark, Germany and Holland. I was prevented by the war from visiting France, though I greatly desired to see it, because its climate and capabilities of cultivation are so much like those of our own country. Everywhere I went I visited farms and farmers, examined drained lands and systems of drainage, and inquired into the methods

and means of agricultural education. I cannot, in the compass of a lecture, do more than glance at some of the points which most interested me. And of farms and farming I may describe what I learned in a day at Castle Acre, in Norfolk.

Through the influence of favorable letters of introduction from Hon. Clare Sewell Read and Dr. Aug. Voelcker, I enjoyed the opportunity of visiting the farm of Robt. Leeds, at Castle Acre. It is considered a model of Norfolk farms, and Mr. Leeds, its occupant, did all he could to show me a fair specimen both of Norfolk farming and of Norfolk hospitality. The farm is some 20 miles or more east of Lynn, and is reached by a carriage drive of six miles north from Swaffham station, on the railway between Lynn and Norfolk. It lies in the chalk district, and the soil is everywhere underlaid by that substance, which is only a foot or two beneath the surface. The land is rolling, the soil loamy, and sufficiently dry to need no artificial drainage. The farm comprises 1,200 acres, of which 1,060 are under cultivation, 70 in permanent pastures, and the remainder in the grounds about the homestead and buildings. There are cattle sheds and feeding places at four places on the farm, so that the hauling of manure and of heavy crops for feeding may be shortened. No barns or sheds are provided for storing grain or hay, stacks being considered as economical and safe. Neither is any shelter provided for the sheep.

Mr. Leeds went with me over the farm, walking steadily for more than five hours. He explained in detail his method of manuring, cropping, tillage and stock feeding. His aim is to keep one quarter of his farm in wheat, one quarter in barley, one quarter in roots, mangolds, swedes, and common turnips, and the remaining quarter in clover and cultivated grasses. It should be remarked, however, that the rotation is varied from as the exigencies of the market and the judgment of the farmer dictate; thus on very good ground two crops of wheat are taken in succession, and a crop of turnips between them. Mr. Leeds had a fine field of early sown rye after wheat, which was intended for early pasturage for his sheep—3½ bushels of seed per acre were sown. A crop of oats may take the place of the barley, and for purposes of tillage or improvement some one of the leading crops may be greatly in excess of the others, for example, the root crop, on this farm, covered more than 300 acres last year.

The tillage of the land is thorough—steam cultivation is used as far as possible, pulverizing the soil to the depth of ten inches. For the crop of mangolds the plowing is done in the late autumn to the depth of eleven inches; and it is again plowed to the same depth in the spring. For the turnip crop, simple cultivation, without inverting the soil, is generally practiced. The plowing for wheat is very shallow, only about four inches; and after the plowing the ground is rolled and then harrowed with a very large harrow, with numerous small teeth; the intention being to get a very fine seed bed of an inch and a half or two inches deep, leaving the rest of the soil pretty

solid. The wheat is drilled in, and on the light soils the ground is again rolled after sowing.

The crop of wheat averages from 32 to 36 bushels an acre, though in exceptional seasons it has gone as high as 56 and even 60 bushels an acre, and in other unfavorable seasons, on the same land, has fallen to 28 bushels. The barley varies from 40 to 48 bushels an acre—last year it was only 40 bushels. Of the weight of the root crop I can give no distinct report; it is enormously large, both in the turnips and the beets. The men were gathering a crop of long red mangolds, and hauling them off to clear the ground for wheat. The foreman said they were taking off 35 large cart loads from an acre. The cart had high sideboards and must have held nearly a ton. They were gathering the turnips in other fields, and the piles seemed to be nearly as large as those of the beets. Of the crops of clover and cultivated grass I got no definite idea; they are not so highly valued as with us, and are used in feeding stock nearly in the same way that straw is.

Enriching the soil is an important part of the farm economy; everything that will help to increase the manure heap, or improve its quality, is most carefully done. The manure is kept under shelter; enormous quantities of feed for cattle and sheep are bought; artificial fertilizers are used largely; and only the sheep, cattle, wheat and barley, are sold off the farms, and just as large a stock of bullocks and sheep is kept as the straw, hay and turnips will support. The amount of dung made is three tons or more an acre for the whole farm. This is used mainly on the wheat and turnips; none is used on the grasses or barley, and artificial manures are bought for the mangolds, and some additional fertilizers for the turnips and wheat. Both superphosphates and Peruvian guano are used.

Mr. Leeds feeds and fattens about 2,000 sheep yearly. He keeps Hampshire and other South Downs, and the lambs raised are a cross of these with the Lincolnshire. I noticed in particular a flock of 300 fine South Down ewes, which were to be kept over the winter for raising lambs. From these he expected to get from 450 to 500 lambs. But the largest part of the sheep are bought to fatten, change the turnips into meat, and help prepare the ground for crops. They were feeding off the turnips when I was there—a plot just large enough to yard comfortably the sheep was enclosed by hurdles—feeding troughs were regularly arranged in the yard for the sheep, the turnips nearest were pulled, sliced, and put in these troughs by boys, and the sheep stood up to these troughs in ranks on both sides. As fast as the turnips were consumed from the ground, the hurdles and troughs were moved forward—the latter being moved six feet each time, so that the whole ground was trodden by the sheep and mixed with their droppings. In addition to the turnips the fattening sheep are fed from a half a pound to a pound of oil-cake daily.

One hundred and fifty bullocks were fattening for the butcher; and 250 are fattened on the farm every year. They are all Short-

Horns, mostly three-year olds, but a few are four years old. They are bought at the markets and are intended to be fattened in the shortest time possible. A judicious selection of these cattle, so as to get those which will make the most growth for the time and feed consumed, is the first element for success in this business. They are bought at prices varying from £20 to £30, and sold at from £28 to £35, and some very fine ones he had were engaged at £48. The average increase in value while fattening is about £10 each. These bullocks are all kept in yards or boxes, and never turned out to graze. At each of the four sets of sheds there are boxes for thirty or forty cattle, and these are occupied by the fattest animals; and the remaining ones are kept in the yards waiting their turns to enter those little boxes from which they are never turned out till ready for the butcher. The boxes are in two rows under the sheds, and there is a passage-way between the rows, by which the feed is carried in. They may be ten feet square; the trough is along the side next the passage, and has parts in it for holding water, turnips, cake-meal and cut straw. The boxes are not cleaned out from day to day, but are kept dry by throwing in a little straw; and as they fill up, the feeding troughs have to be raised. The manure accumulates in the boxes until they contain eight or nine tons each. The daily feed averages two bushels of roots, from twelve to fourteen pounds of oil-cake and as much cut straw as they will eat. He fed out 300 tons of oil-cake last year to his cattle and sheep.

The work on the farm requires 28 or 30 horses. The number of hands employed is variable; laborers' wages, at the time I was there, in November, were 10 shillings a week, and the average through the year is about 15 shillings a week. Much of the harvesting is done by contract, a gang of hands taking the whole work to do at a fixed price. In the dry weather of last year it was very favorable to the workmen, and for the 17 days it lasted, they earned between 7 and 8 shillings a day. The expense for labor on the farm is usually said to be equal to the rent, which may be 35 or 40 shillings an acre. The amount paid out for labor on Mr. Leed's farm is not far from £1,800 a year. The amount paid out for fertilizers I could not learn.

I may also mention some things which I saw at another place in Norfolk. Through the favor of Hon. Clare Sewell Read, I was enabled to witness the operations on his own farm, which he manages in the intervals of his parliamentary duties. He pursues the settled system which has been found to succeed so well in Norfolk; wheat, barley, turnips, clover and grasses are the main crops, and the aim is to keep as large a stock of cattle and sheep as the turnips, hay and straw will support. From this general system, each farmer may vary slightly as his judgment dictates.

Mr. Read called my attention to his Hampshire Downs, which were very fine animals, and which he considered the best for his location. Among his stock of bullocks were a considerable number

of Short-Horns, only a year and a half old, which were nearly fit for the butcher, and as large as our own cattle at two and a half years old.

I was much interested in the working of a chaff-cutter in one of his barns. Instead of having an engine and straw-cutter of his own, he considered it more economical to hire the service of an itinerating one, and have his barn filled with the cut straw and hay at once. The cutter was driven by an eight-horse power engine, and that and the engine were managed by two men. The engine was mounted on wheels, so as to be locomotive and travel on the common roads from one farm to another as its services were needed. It was supplied with coal and water on the farm, and its daily expense for running and attendance was one pound sterling. I neglected to inquire the amount cut in a day, but it was many tons, for it needed feeding as fast as a threshing machine. Mr. Read was cutting and mixing in the same pile, ten tons of straw, ten tons of hay, one ton of barley or malt sprouts, and two tons of ground rock salt. This was intended for his fatting as well as his store cattle. The salt was not expensive there, the two tons costing only twenty shillings. The salt would absorb moisture from the air, and with the straw and hay would soon become damp and soft, improving the taste of the fodder, and answering almost the same purpose as steaming. This process seemed to be nothing new there, and I was assured it was altogether satisfactory.

Mr. Read's chief manure for turnips was super-phosphate of lime, of which he used four hundred weight per acre, and it was interesting to know that there, as well as here, they are obliged to depend on the integrity and reliable character of the dealers. The price of super-phosphate was £5 10s. a ton, and Mr. R. had been pursuaded to take part of his supply from a new manufacturer. The turnips where this was used were not half as large as those where his usual kind was applied, and on having the new kind analyzed and valued, he found it to be worth only £2 10s. a ton. The point in which the English farmer was in advance of ours was, that he was able to detect the fraud and determine its amount, while ours would have remained in uncertainty, or condemned all artificial fertilizers.

A field of Italian Ray-grass had been mown twice that season, yielding a good crop each time, and when I saw it, October 30, it was excellent pasture. A good deal of mustard was sown as early food for sheep.

A visit to the Norwich market was one of the instructive novelties to which I was introduced by Mr. Read. It was only the usual weekly market, but the supply of stock of all grades of cattle, sheep and hogs was very large—that of horses not so large—and the gathering of farmers from all parts of the country was quite equal to the supplies of stock, and to the large sales which were made. The corn market was open in the afternoon, and it seemed as if every man who wanted to buy or sell anything, could here find his customer. I

am too little of a judge in the marketing part of farming to describe properly what I here saw, but I could not help admiring the arrangement which brought so many buyers and sellers together on such fair and equal terms, and I think that a part, at least, of the excellence of British agriculture must be due to the influence of these frequent meetings of intelligent and enterprising farmers, where their efforts must every week be quickened by the knowledge of what the market demands, as well as what the best of their competitors can supply.

Scotch farming is fully equal to the English, and I will give some of the particulars of a visit made to a farm near Edinburgh:

Among the prominent farmers of Scotland no one is more widely known or more highly esteemed than George Hope, Esq., of Fenton Barns, East Lothian.

When in Sweden, at both the Agricultural Colleges, I heard the name of Mr. Hope coupled with accounts of the best system of improved agriculture, and his farm cited as a model. The county of Haddington, or the East Lothian, has been justly distinguished for its highly improved agriculture, and no part of it more than this district, which lies about twenty miles east of Edinburgh, and on the south shore of the Frith of Forth. Mr. Hope occupies a home-farm of over 600 acres, and another farm of some 300 acres two or three miles away, on the very borders of the Frith. The soil of the home-farm is heavy, while that of the other is a light sand. No longer ago than 1836, a considerable portion of the home-farm was in heath, unenclosed, wet, springy and worthless. The clay from this tract was used in making draining tile, ditches were dug in it, and that, with all the rest of the farm which needed it, was thoroughly underdrained with lines of tile-drains, 30 inches deep and 18 feet apart. The whole farm was soon brought into cultivation, and the average crops raised from it have increased year by year; at that time turnip culture was scarcely begun, last year he devoted 110 acres to that crop; wheat was then thought good at 28 bushels an acre; now the crop ranges between 40 and 50 bushels per acre, and at least one quarter of the farm is cropped with it. The barley crop has been quite as largely increased, and only the oat crop is stationary. As large a stock is kept as the straw and turnips will support. About 100 cattle are fatted every year, and 1,000 sheep are kept on the farm. The wheat and barley are sold, and linseed-cake meal and Indian corn residuum from the starch factories, are bought to fatten the stock. About £1,000 are spent annually for the cake-meal, or its equivalent corn-wastes. Potatoes, beans and tares are also sold from the farm.

To keep up the fertility of the soil, he spends about £1,200 a year for artificial manures. I saw 40 tons of Ichaboe guano in one pile. Super-phosphate and ground bones are also used—the latter being preferred for the turnips, while guano is more used for the potato crop.

The rotation is a six-course one of clover and grasses, oats, pota-

toes and beans, wheat, turnips, wheat and barley. Frequent variations are however made from this course, as the crops, seasons or markets may require. The weekly markets are attended regularly, and there is always something to sell from the farm—usually wheat or barley, as threshing is done every week for the convenience of having fresh straw for the stock. At the markets, too, the supply of fertilizers can be bought as they are needed, and there also farm stock can be regulated by proper purchases or sales.

It is always uncertain whether it will pay best to sell the potato crop or to feed it out. An average crop there being 8 tons to the acre, it is more profitable to feed them at 40 shillings the ton; but at the price they were then bringing, 50 to 56 shillings a ton, it was better to sell them.

Eighteen men were steadily employed on the farm, and in busy seasons many day laborers were also employed. Twelve pairs of horses were kept in steady work, beside three stationary and one movable engine. The stationary engines are used at the three barns for driving the threshing machines and straw cutters, and the moveable one for operating the steam plow. Everything is done thoroughly and well, and though the expense of bringing the land to its present high condition of fertility has been large, still it pays.

The Scotch system is to lease farms for long terms, 19 and 21 years being the most common. Mr. Hope assured me that in the first 19 years of his occupation of his present farm he saved nothing from it—all the profits being consumed in improving and enriching the land—and that it was only with his second lease of 19 years, which is now almost ended, that he had been able to save anything. I should judge it was now yielding him a handsome income.

It was a pleasure to go over the farm and see the crops which were growing and the harvest which had been gathered. I was there on the 12th of November; the day was rainy, and at its close the storm turned to snow, but they were looking for open weather for some time later. Most of the turnips were still in the fields, and the wheat was not all sown. Everything about the farm showed prosperity.

Does this prosperity come from the long leases and the stimulus which they give to the tenant to use his utmost skill to get the largest profits? Is the prosperity due to the superior education and skill of the Scotch workman? Or does the damp, cool climate, free from our severe drouths, enable them to manure higher, and so get a more continuous growth and a larger crop? All of these, doubtless, have their influence, and together they make the Scotch farming the model for that of all other countries.

OBSERVATIONS IN NORWAY.

As a specimen of what is done in agriculture, I give some notes made in Norway:

My travels in Norway were confined to a trip up the Christiana Fiord, to the city of Christiana, and thence across the country by the Kongsberg silver mines, and over the mountain plateau called the Fille Field, to the Justedal glaciers and the Sogne Fiord, and back by another road to Lake Miosen, and so to Christiana again. The soil, climate and productions are so different from ours that one looks at the country more as a curiosity than as a legitimate subject of study. The rocks are mostly crystalline, and of the azoic age, and the soil upon them is thin, cold and stony. The shape of the country is sufficiently familiar to every school-boy; it is 1,080 miles long, 275 wide in the broadest part and only 20 in the narrowest. A very large part of its surface is elevated ground. What we have been accustomed to think of as a narrow ridge of mountains running through its whole length, is really a broad mountain plateau, so extensive that from its top the valleys and streams which cut into it, occupy only a very small proportion of the whole. The entire area of Norway is 123,000 square miles, 40 per cent. of the southern half of which is said to be 3,000 feet above the sea level. The line of perpetual snow is 4,300 feet high, at 60 degrees north latitude, and 3,200 feet at 70 degrees. The remarkable character of its climate will appear more strongly, when it is farther considered that the south end of the country is in latitude 52 degrees, and the north end in latitude 71 degrees, and that Christiana and Bergen, the only cities in the country, are very nearly in the same latitude with the south end of Greenland. The climate is much less variable than ours. At Bergen, on the sea coast, west of the mountains, the mean temperature in January is 32 degrees, and of July is 58 degrees. The mean for Christiana in January is 23 degrees, and for July is 60 degrees, while at New Brunswick, N. J., our mean temperature for January is 23 degrees, and for July is 74 degrees.

In addition to the perpetual snow on the high mountains, we saw the ground white with snow far down on the mountain sides in August, and the potato vines were all killed by frost some days earlier.

Oats, barley and rye are the grain crops. Wheat is raised in very small amount. We saw many fields of oats and barley which were so hopelessly green the first of September, that there was no prospect of their ripening at all. It was interesting to notice with what care patches of dry, warm ground were picked out on which to sow the grain, for the ground must be dry and the season favorable to mature these crops at all. On the sides of the mountains the highest ground on which the barley and oats will ripen is very plainly seen. At one place, where it seemed very well defined, I took the height by an Aneroid barometer, which read 27 40-100 inches, and indicated about 2,500 feet above the sea level. Higher than this there were no attempts at cultivation, and with the cool weather, which of course retards evaporation, and so leaves the ground wet and cold, only a small part of the country below this level is cultivated. It is estimated that one-tenth part of the country is capable

of being cultivated, but less than one hundredth part is really under tillage. And this small part is scattered in small patches over the country. The million and a half of inhabitants nearly all live in the country, and the greater portion of them are absorbed in the struggle to get from the ground enough to keep them alive through the year.

The amount of work necessary to raise and secure their scanty crops is vastly greater than anything we are acquainted with. The fields are small and irregular in shape, so that labor is wasted in tilling them. There is so little warmth in the sunshine that they cannot make hay on the ground, and the green grass has to be hung up on racks to dry before it can be put away, and the grain is all tied in bundles when first cut, and then strong stakes are set in the ground, and the bundles in pairs are hung on either side of these poles, pair after pair being put on until the pile is as high as a man can reach. In these grotesque looking shocks the grain is allowed to stand until it is dry, when the men and women carry it on their backs to the barns.

I was not well enough acquainted with their language to get a clear understanding of the amount of their crops, and should judge from the appearance that they were not large; though some reports given me at the Agricultural College at Aas, seemed to show that they were quite as large as in warmer climates. The best farming country that I saw was on the shore of Lake Miosen. I afterwards saw some land from which the stones had been picked off, and which had been thoroughly underdrained. The crops upon this soil were good, ripened in season, and the sod and stubble looked as if they belonged in a warmer climate. Underdraining is, I think, to be the saving of this cold country. It has been estimated that if the average summer heat of Norway were 4 degrees lower, one quarter of its surface would be covered with perpetual snow, but our best authorities on drainage say that the temperature of the soil is raised 3 or 4 degrees, and sometimes much more, by being well drained, so that it will be seen the improvement in temperature need be but a very moderate one to make the country capable of producing crops with certainty. That this slight variation is all that is needed seems very plain from the character of the vegetation which prevails at different heights. A rise in height of about 350 feet is said to lower the ordinary temperature 1 degree Fahrenheit. In latitude 70 degrees, pine ceases to grow at 780 feet above the sea level, the white birch at 1,580, the bilberry at 2,030, the mountain willow at 2,150, the dwarf birch at 2,740, and perpetual snow is found at 3,480 feet, according to Von Buch.

With these moderate changes of level, which indicate differences of temperature of from 2 degrees to 6 degrees, trees cease to grow, and the same thing is true of farm crops; but these differences are fairly within the control of the farmer, by means of thorough drainage, and in this is the hope for Norway. The most abundant tree everywhere is the white birch, and it marks a soil which is cold and

wet. Take away the water and other vegetation will thrive. Pasturage and the raising of stock and dairy products will yet be the prevailing branches of farming in that country.

The strong point in the management of their model farm is its dairy, and everything is arranged to make dairying a profitable business. The cattle are carefully herded, housed and fed; the milk, as soon as drawn, is cooled by setting the vessels in ice water, and keeping them there until cream enough has risen. It is then skimmed, the cream is churned and the milk is set for cheese, and finally the whey is dried down and made into a kind of cheese.

From 100 pots (or 94 quarts) of milk they get six to eight pounds of butter, ten pounds of cheese, and from thirteen to fifteen pounds of whey cheese. They keep fifteen or twenty goats, and the milk of these is added to the whey to make the whey cheese, but this is only a matter of taste, for there is a large quantity of this cheese made simply from whey without anything else whatever. In the annual reports of the college, the director publishes every year an account of the milk yielded by each cow, month by month. From these tables I have condensed the following statements, and have reduced the weights and measure to our standards. The Ayrshire cattle are fair specimens of that stock, and are liked better than the native Telemark cattle, though tender and more subject to disease of the lungs. The returns are made from April 1 to April 1 of each year. From April 1, 1863, to April 1, 1864, there were twenty Ayrshire cows which gave milk. Their live weights were taken at the beginning and end of the year, and I have set down the average.

	Live weight in pounds.	Quarts of milk in the year.
Average	1,000	2,925
Greatest	1,129	3,840
Least	859	2,030

20 *Ayrshire Cows from April* 1, 1865, *to April* 1, 1866.

Average	999	2,772
Greatest	1,136	3,771
Least	865	882

20 *Norwegian Cows from April* 1, 1865, *to April* 1, 1866.

Average	867	2,018
Greatest	1,064	3,695
Least	670	1,110

21 *Ayrshires from April* 1, 1866, *to April* 1, 1867.

Average	967	2,750
Greatest	1,048	4,558
Least	828	466

16 *Norwegian Cows for the same time.*

Average	828	2,090
Greatest	956	2,792
Least	664	1,407

21 *Ayrshires from April* 1, 1867, *to April* 1, 1868.

Average	988	2,351
Greatest	1,087	4,125
Least	830	1,073

18 *Norwegian Cows for the same time.*

Average	786	1,975
Greatest	959	2,837
Least	604	1,234

On the New Jersey Agricultural College farm we have several Ayrshires, whose product of milk has been recorded for the last year, and I append the results during the year 1870 for the purpose of comparison.

		Weight in lbs.	Quarts of milk.
Medium Ayrshires.	Nettie	940	2,901
	Nellie	935	2,893
	Mag	1,000	2,957
Extra Common Stock.	Bergen	1,024	2,843
	Julie	968	2,921

Our average Ayrshires are better milkers than the common stock —agreeing with the results in Norway, and they are always in better condition on the same feed.

DUTCH DAIRIES.

The following on dairies in Holland may be stated in this connection:

One of the first things that attract the attention of the traveller in Holland is the great number of cattle. They are to be seen everywhere at pasture, and their decided colors of black and white in large spots make them conspicuous objects. Rarely they are seen black with a broad belt of white. The fame of the Dutch cows for dairy purposes made me interested to inquire into their peculiar excellencies. I visited only two or three of the dairies, and got the most definite information at one in the Beemster, some fifteen or twenty miles north of Amsterdam. Wouter Sluis occupied the farm, and was evidently thoroughly informed in his business. The land was flat, ditched, and though at the level of the tide-water was well drained. He occupied eighty-four hectares, (two hundred and seven and one-half acres), and keeps nearly all of it in meadow and

pasture, plowing very little. His stock consists of forty-six head of cattle, of which twenty-six were milch cows, and he makes butter and cheese. His sons had kept a record for the year 1870, up to the time I was there, October 20, and they gave me the following figures from it, on the product of milk :

Monthly average of the whole twenty-six cows, in quarts, for each month, November and December being estimated.

	QUARTS.
January	546
February	585
March	532
April	519
May	642
June	546
July	493
August	464
September	252
October	189
November	126
December	
	4894

Monthly average through the year, 408 quarts.

Daily average for each cow, 13.6 quarts.

The cows have been selected with great care. No pedigree is kept in Holland; but Mr. Sluis judged of the qualities of his cows by the size of the milk-mirror, by the yellowness of the skin, the abundance of the scurf on it, and the clear definition of the black and white colors. They were all carefully blanketed when I was there, and were constantly in the pasture. The day was very rainy and cool, but no shed was provided for them; and I concluded they could get no shelter until the winter stables were made ready for them; and at that time the stables were partly in use for the cheese room, and were altogether too neat and clean for the shelter of cows. He feeds the cows beets, linseed meal and straw during the season they are not in pasture. The average size of his cows is a little greater than ours, but not much; I should judge them to weigh from nine hundred to one thousand three hundred pounds, though he thought them not quite so heavy as that. His bulls were very large and fine; he had one not long since that weighed two thousand two hundred pounds.

He had not made up the account of butter and cheese for the year, but promised to send it to me, and I am sorry not to have it now to put in with the account of milk. He told me, what is also plain from the above statement, that the cows gave more milk when in the stable than when out at pasture; but he said it did not yield as much cheese; that it took twenty-four quarts for four pounds of cheese in winter, while twenty-one quarts in summer would yield four pounds

The milk is allowed to stand twenty-four hours for the cream to rise, and they expect to get two and one-half pounds of butter from fifty-four quarts of milk, and also to make a small quantity of cheese from the whey, additional to the chief product of cheese. The following, from Staring's Netherland Farmers' Handbook, gives the average for Dutch dairies, and may serve as a basis for comparison with the excellent dairy of Mr. Sluis:

"The average yield of Dutch cows appears to be from two thousand eight hundred and thirty-five to two thousand nine hundred and forty quarts, and of the best, three thousand one hundred and fifty quarts, during the three hundred days they are milked; but in the neighborhood of Haarlem, a stable of twenty-six cows averaged three thousand eight hundred and forty quarts each; in the Beemster, three thousand seven hundred and eighty quarts; in the vicinity of Voorst, near Tutphen, three thousand seven hundred and seventeen quarts. Another stable near Haarlem, of thirty cows, three thousand four hundred and thirty-three quarts; and in one near Lochem, in Gelderland, sixteen cows, averaged three thousand three hundred and twenty-three quarts each. It is well known that some Dutch cows, immediately after calving, sometimes give as much as twenty-five and even thirty-two quarts per day, which makes the amount for the year from four thousand seven hundred and twenty-five to five thousand one hundred and forty-five quarts."

The following extract from the milk list of 1861, of a farm of twenty-six cows, at Haarlem, will indicate the weekly amount. There was a regular increase of milk after the 11th of May, and a diminution after October 12th, in consequence of going out to pasture and returning to the stall.

Cow No.	25, in	44	weeks, gave	5,100	qts., or	17.8 qts. a day.
"	133,	38	"	5,071	"	14.7 "
"	298,	43	"	3,800	"	13.5 "
"	322,	32	"	3,185	"	11.0 "
"	484,	44	"	2,462	"	7.3 "

The dairy of Mr. Sluis is much above the average, I have no doubt. I visited one in the Haarlem Meer polder, in which the cows showed the same care in the selection and management, but I could not there get the statistics of production.

The climate of Holland is thus described in Blackie's Gazeteer: It is, "from the maritime exposure and originally marshy character of the country, extremely humid, changeable and disagreeable; violent winds with varying temperature frequently blow from northwest or southwest, and heavy sea fogs are driven in, which injure vegetation. The mean temperature is not lower than in like latitudes in the British Islands, and the quantity of rain (26 inches) is somewhat less, but the winter is much more severe, and the sky is almost always overcast and troubled. The bright days hardly exceed forty in the year. Low fevers visit the marshy districts in autumn, but the dry cold of winter restores the peasant's health; and although the cli-

mate of the Netherlands is to strangers cheerless and distressing, yet its noxious qualities are unable to cope with the countervailing influence of good food and clothing, and habitual cleanliness; the Dutch give particular attention to these domestic safeguards, and, notwithstanding the ungenial climate in which they live, longevity is not rarer among them than elsewhere." I believe this description is correct; it certainly agrees with my experience during the few days I spent in the country. In all the richer portions of the country—and in fact in more than half of the whole area of 12,000 square miles—the water in the ground is only from eighteen inches to three feet below the surface. Under such circumstances it is wise to use the land for pasturage and stock raising, rather than for grain or other cultivated crops.

There were in 1864, 1,333,887 cattle in Holland, of which 943,214 were cows, and these numbers are not so large as they have been in some other years. 32,000,000 pounds of butter and 61,000,000 pounds of cheese were exported from the country in 1864. The population of New York is about the same as that of Holland—the whole number of cattle of all sorts in that State in 1870, was estimated at 702,000. The whole amount of butter exported from the United States from June, 1869, to June, 1870, was 2,039,488 pounds, and of cheese for the same time was 47,296,323 pounds. There is nearly, but not quite enough grain raised in Holland for the supply of her own people.

After seeing these dairies, and the remarkable amount of their products, I am at a loss to know how much is to be attributed to the peculiarities of their climate, soil and careful treatment of their cattle; and I regretted that I was not familiar enough with the Dutch language to inquire more minutely into the details of their dairy management. The leading business of the country is commerce; agriculture has to take the less prominent place, and there is much less printed about it than there is in England or our own country. The wonder to a stranger is in the marvellous neatness of the cow stables. The cattle are turned out from them in the spring, and are kept in the pastures day and night until the grass fails. As soon as the stables are vacated, they are washed out clean, the floor is sanded, and in some cases tiles are laid, so that the stables are just as neat and clean as the dwelling-house, which is under the same roof, and only separated from it by a partition and door. These stables are too neat for temporary use during the cold storms of spring or autumn, and as a substitute for this the cows are almost uniformly covered with blankets or other cloths, when in the pastures. When the cows are brought into the stables for the winter, they are kept with the same care that the best of horses receive with us; the cattle being curried and the stables being frequently and thoroughly cleaned and washed out with water.

There have been some full blooded and many grade cows of this

breed in the vicinity of New Brunswick, and they are uniformly good milkers.

The greater part of Holland is lower than the sea level, and is only kept from being overflowed by the waters of the German Ocean by the ceaseless vigilance and untiring industry of its people. A considerable part was originally marsh land, and of course flat, and just at the level of ordinary high water. Still a large area of land is uneven and lower than the marsh, which has absolutely been reclaimed, not only by shutting off the tides by means of dykes, but also laid bare and dried by pumping the water that was on it, over the dykes, and letting it run off into the sea. The former are the pastures and meadows, the latter are the grounds that can be profitably tilled. The whole area of the Netherlands is 8,076,900 acres.

ACRES.	
54,834	area covered with buildings.
1,721,590	arable.
2,973,880	pasture.
554,515	woods and bushes.
1,746,290	waste ground, mostly wet and unreclaimed.

The pasture land and some of the arable land is below the sea level, so that it is safe to say that one-half of the kingdom is below the level of the sea. In the provinces of North and South Holland the proportion is much greater, thus:

ACRES—N. HOLLAND.	ACRES—S. HOLLAND.
582,920	745,940 whole area.
6,175	7,410 occupied with buildings.
74,100	135,850 arable.
370,500	432,250 pasture.
17,290	37,540 woodland.
74,100	24,700 waste grounds.

This large body of pasture and arable land owes its excellence and even its existence to the dykes which surround it, and which are made high enough to shut out any storm tides or waves that may occur. The pasture lands are mostly very near the level of ordinary high-water; but some lands are much lower. The Haarlem Meer polder is on the average 13 feet lower than high water mark, and there are some smaller ones as much as 18 feet below high water mark. The ordinary tides on the coast rise and fall 13 feet or less, but storm tides have been known to rise 7½, 8 and even 9 feet more, and in addition those portions of the coast which are exposed to the full sweep of the wind and waves, have the water driven in still higher, so that they are obliged to make the dykes very high. Those at the Helder are from 12½ to 15½ feet high, and those along the Zuyder Zee are from 11 to 12 feet. Some are reported to be still

higher than any of these, but I have no definite account of them. These dykes are made and maintained at an enormous cost of labor and money, and any considerable opening in them would lay the whole country under water. They become one of the defenses of Holland, for if they were cut to let in the water upon an invading army, the effect would be more summary and decisive than from a pitched battle. This was done in time of the Spanish wars, and last summer, when the peace of the country was threatened, all the arrangements were made to open the dykes and flood the country. The necessity for it did not arise, and it is to be hoped that none may again occur. In the old way of arranging the dykes, sluices and pumps, the polders (as the drainage plots are called) were small, averaging about 1,200 acres each, but in recent times, and with the introduction of steam pumps, it has been found economical to make them much larger. The Haarlem Meer contains 45,000 acres, the new polder in the Y is to cover 12,000 acres, and some of the projected new ones are to be still larger.

In the early stages of drainage, they depended on sluices in the dykes for taking off the water. These would open at low water and allow the rain and leakage water to run out, and would close at high water so as to prevent the rising tide from running in. As the country became drained, the soft and spongy earth settled and became so low that the water could not run out low enough, even at extreme low water, and they were obliged to construct wind-mills and pumps to be driven by them, to raise the water sufficiently high for running it into the sea. This process has been carried on, following up the settling ground, until there are places so low that the water has to be raised 15, 20, and in a few cases 25 feet, before it will run out. With the experience they have accumulated, and a knowledge of the rain-fall that is to be expected in any month, they are able to calculate the power needed to take off all the water that will come upon the land. For their best pasture lands, the water need not be more than a half metre (18 inches) below the level of the surface, and if less even than that, it does no injury to the grass. For draining such lands, the wind-mill furnishes a sufficiently steady power, and most of the pumping is done by the wind; but in the larger polders, and in those where the water level needs to be kept a metre (3 1-10 feet) below the surface, as is the case where grain and vegetables are grown, the steadier power of steam is preferred, and the difference in cost is not very great. Some of the meadows and pastures are kept dry at a yearly expense of not more than fifty cents an acre; and in the Haarlem Meer polder, where the water is kept steadily 21 feet below the sea level, and more than 3 feet below the lowest surface, the annual cost is $1.62 per acre. This seems to the upland farmer to be a heavy tax; but when it is considered that for it the farmer gets his land thoroughly drained and effectually protected from drouth, and also gets a soil that is rich, mellow and capable of cultivation at smaller cost than any upland, he may easily understand

why the Dutch farmer would rather reclaim and occupy these lands than to trouble himself with dry and hilly grounds.

Self-preservation was undoubtedly the first inducement to construct dykes and protect their lands from the sea, and the gradual settling of the ground has compelled them to go on making the dykes larger and stronger, but the result has shown that it is profitable to do so. The Haarlem Lake is a case in point. The land it covered was, some 300 years ago, an improved and rich pasture, but the sea broke in, drowned the inhabitants, destroyed all the improvements, and washed out the surface so as to leave a considerable lake. With violent storms, this continued to increase in size, and to be more and more injurious to the adjoining flat country by its overflows when the water was driven by high winds. It had reached a size of 70 square miles, a depth of 13 feet, and the yearly expense of keeping it within its bounds was $20,000. In 1840, the government determined on the drainage of the lake, and for that purpose organized a commission, with a credit of $3,200,000. A canal was made entirely around the lake, to isolate it from the adjacent waters, to furnish means of navigation for the traffic which had heretofore been done on the lake, and to carry off the water as it should be pumped out. This canal was 37 miles long, 120 feet wide and 9 feet deep.

The water in the lake, together with that which would fall in rain during the progress of the work, was estimated at 1,000,000,000 tons. To pump this out, three stations at different places on the bank of the canal, were established and a steam engine, with powerful pumps, was set up at each. These engines were capable of raising 110 tons of water ten feet high at each stroke, and of discharging 1,000,000 tons in 25½ hours. The work of pumping began with one engine on the 7th of June, 1848. The other two were set at work in February, 1849. At the end of a year the water had been lowered 4½ feet; the shallower portions near the shore were drawn off, and drains were begun to carry the water freely to the pumps, and as the work progressed, ditches from 60 to 80 feet wide were opened, so as to give the water a free passage to the pumps. These ditches were at first 10 feet deep, then lowered to 13, then to 19, and at the last to 21 feet. In July, 1852, the ground was dry, and the work, which had gone on steadily for four years, was considered to be ended.

The whole cost of the undertaking was $3,600,000. The land was first valued at $33 an acre; but subsequent examination proved that it was worth much more than that; thus in 1853, at a sale, 1,936 acres brought $230,000, or an average of $118 an acre. At the time of my visit last year I learned that the land is now worth about two hundred dollars an acre, or the whole area is worth $8,640,000. It is all in cultivation, is traversed by excellent roads, dwellings and farm buildings are located everywhere in it, the same as if they were above the sea level, the land is drained and dry, and trees, shrubs and farm crops of every kind are flourishing.

The success which has attended this has led to plans for other and larger works still. The great ship canal in process of construction from Amsterdam 16 miles west to the North Sea, passes for 12 miles of its length through a body of shallow water called the Y. The land under this body of water, which amounts to 12,000 acres, is a perquisite of the Canal Company, and they expect to dyke and drain it so as to make a considerable profit from its improvement. No less than ninety of the smaller lakes in Holland have been drained.

The management of the drainage works of Holland is in the hands of a special department, and the best engineering talent of the country is employed in carrying out the plans. It has been reduced to a system, and skill and economy are both carefully consulted at every step.

In Sweden I first saw a beet-sugar factory, but I afterwards saw many others. The production of beet-sugar, though talked about as one of the curiosities of agriculture, has hardly yet engaged the serious attention of our farmers. But in Europe it is entirely different. There it is already established and profitably carried on in France, Germany, Austria, Russia, Holland, Belgium, Poland and Sweden. The manufacture is more than 600,000 tons a year, which is about a quarter of all that is produced in the world. The price has gone steadily downwards, till now, raw sugar free of taxes is sold at five cents a pound, and in all places away from the seaports beet-sugar is the only kind used.

As soon as I landed in England I began to realize the importance of this new branch of agricultural and manufacturing industry. The English with their East and West India Colonies, in which cane sugar is a chief product, and with their immense commercial interests to foster, have strongly and persistently ridiculed and opposed the manufacture; but they have already begun to yield to the weight of the facts against them. Mr. Duncan, of Lavenham, Suffolk, made 4,500 tons of beet-sugar last year, and the reports of his success are of the most flattering kind. I have before alluded to the experiments of Mr. Campbell, at Buscot Park, near Faringdon in Berkshire, and his trial of deep plowing. He had last year 1,700 acres of sugar beets, raised for the purpose of making alcohol. His crop, though uneven as would be expected from such an entire upturning of the soil, is said to have been a good one. I have not heard of its profits, but as preparing the juice for distillation is much simpler than for sugar-making, I have no doubt it is a success.

Near Malmo, in Sweden, which is in latitude 55 degrees 30 minutes north, I visited a new and very large beet-sugar factory. I saw a large one also on the bank of the Haarlem Meer polder in Holland, both of which would seem most unlikely localities for sugar-making. The factories are in greatest numbers in Germany and France, and while on account of the war I could not visit those of the latter country, I had opportunities to see all that I wished in the former.

There were two or three large factories and one refinery in Halle,

and I enjoyed the privilege of seeing and inquiring into everything that I chose about one of these establishments, both in the factory and on the farm. It is the property of a stock company, with a capital of perhaps $100,000. The factory is in the city, and they own a farm of 1,900 acres about two miles out. One-third of this is kept in beets, and they buy the beets raised on 600 acres of land additional, which is enough to stock the factory, and they produce about 1,200 tons of sugar a year. They employ 400 hands on their farm, 200 of whom are at work in the factory during the sugar-making season, which extends from September till May. The establishment is well managed, and the stockholders are satisfied—there is no stock in market—and I could not learn what their profits amounted to.

The country about Halle is rolling, the soil a mellow sandy loam, highly cultivated and productive. The variety of beets cultivated is the White Silesian. Those most profitable to grow are conical, smooth, with a line of fine fibrous rootlets running in a spiral line down one side of them. Their average weight is from one and a half to two pounds each; they grow entirely under ground. They may be grown much larger, but the percentage of sugar is not so great. The weight of crop they consider most profitable, is about twelve tons an acre.

The ground is plowed late in the fall, fifteen or sixteen inches deep, and thoroughly manured, and is then plowed lightly once or twice more before planting, so as to have the manures thoroughly mixed through the soil. They use all the barn-yard manures they can get, and buy guano, phosphate, potash manures, and whatever the market offers at the most satisfactory rates.

The seed is planted early in May, in drills eighteen inches apart, and the beets are thinned out so as to be eight inches apart in the row. The seeds are put in with a peculiar drill and dibble, which is drawn by a horse. The after cultivation is partly by horse-power and partly by hand. A cultivator of three double mouldboard plows was used for the last dressing. My visit was on the 4th of October, when the roots were just matured and the gathering was in full operation; though frost had not yet been observed. The fields were nearly free from weeds, the common poppy with its red flowers being by far the most conspicuous. The roots were being pulled and topped by women and children. They were carrying them to the factory for the daily use at that time, but the larger part of them were to be gathered in piles and covered with straw and earth, in which condition they can be kept until needed for use during the winter and spring. It requires good ground to grow beets profitably. They are usually raised after rye or oats, and sometimes two crops in succession are raised, the latter being designed to get the benefit of manures that had been put on the preceding crop. The beets may be followed by rye, or potatoes and then rye. Clover is raised to some extent, but not largely; about one-third of the land is

kept in beets, and the fertility is kept up by the manure from a large stock of animals, and by buying freely.

Two hundred oxen and two thousand sheep were kept upon the farm and fed on the beet-pulp and other produce of the farm. The sheep were kept solely for fattening. The oxen were used for the farm work, but one hundred and fifty of them became fat enough for beef, and were sold at an advance price each year. All the pulp from the factory is brought out to the farm where the cattle and sheep are kept. It amounts to one-fifth the weight of the beets, or two and a half tons an acre; so they must have at least 3,000 tons a year to feed out. As fast as it is brought out it is thrown into large pits, where it is carefully trodden down by a man who is used to the work, and the pit is filled and piled above the surfaces, and then covered with straw and earth. It sours a little, and undergoes a slight change in color, but it is not damaged at all even when kept for two or three years, and the stock continue to eat it freely. They have twenty-two of these pits lined with brick, each of which is fourteen feet long, ten feet wide and thirteen feet deep. Animals, when fed upon pulp alone, need nearly twice as much by weight as they do of good hay.

The beets, when received at the factory, are tumbled into a cylinder which revolves in a trough of water, and are rolled around in it till they are washed clean. They are then carried in an elevator to an upper floor of the building, where the crown and all that has grown out of the ground is cut off as worthless for making sugar. The roots are then weighed by an excise officer, for the purpose of estimating the duty, which is nearly eighteen cents a hundred weight. They are next thrown into a rasping machine and made into pulp. The pulp is then put in iron boxes, and the sugar is taken out by a kind of diffusion process. This will be understood when it is considered that the roots contain ten per cent. of sugar, and that if an equal weight of water is put on the beet pulp, it ought to take out five per cent. of the sugar; if this water is drawn off the pulp, and fresh water again put on, one half of the remainder, or two and a half per cent., should be taken out, and if again drained and fresh water added, one and a quarter per cent. more should be withdrawn, and only one and a quarter per cent. of sugar left in the pulp. Practically the pulp is soaked three times in this way, but fresh water is used only the last time; that drawn from the third soaking is used for the second, and that which was drawn from the second is used for withdrawing sugar from the fresh pulp. That drawn from the fresh pulp is carried to the clarifying vessels, and it carries with it sugar amounting to from eight to eight and a half per cent. of the original weight of the beets.

It should be remarked that the most common way of getting out the sugar from the pulp is to squeeze it out with the juice, by powerful hydraulic presses, and in the diffusion process the pulp is pressed to extract the water and juice from it after the last washing. The

juice is then drawn into a large kettle and heated, and some milk of lime is added; by this means a thick scum is raised to the surface so that it can be skimmed off. The juice is then subjected to the action of carbonic acid to remove the excess of lime, filtered through animal charcoal to clear it, after which it is drawn into vacuum pans and concentrated to syrup. The syrup is again filtered through animal charcoal, and then concentrated by further evaporation until it will crystallize. It is then poured into moulds shaped like our old fashioned sugar-loaves, and allowed to become cold and solid. While in the mould some clear syrup is poured on it, a part of which filters through, carrying with it every trace of coloring matter, and the loaf of pure white sugar is left ready to be trimmed, papered and sent to market. The refined beet-sugar cannot in any way be distinguished from cane sugar.

The apparatus for sugar-making is very extensive, and to a stranger seems complicated, but it can soon be understood; and ordinary laborers can do most of the work, only a few skilled workmen being needed. One important advantage that it has is, that the very workmen who are employed in raising the beets in summer, find work in making sugar from them in winter. The washing, pulping and pressing out the juice has to be done with the temperature not higher than sixty degrees Fahrenheit, while the concentration and crystallizing are done in rooms which are heated to more than one hundred degrees Fahrenheit. Alcohol, molasses and a small quantity of potash salts are obtained in the factories from the otherwise waste products, and help to swell the profits of the manufacture.

The effect of cultivating the beet for sugar upon the country where it has been done, is most beneficial. The average crops of wheat, rye, oats, barley and potatoes have been largely increased in the countries where beet-sugar is made, and the amount of meat for food is much greater, and the value and condition of land is much improved.

The higher price of labor with us, and the higher rates of interest, tend to discourage efforts to establish this manufacture in our country. A large establishment, put up in Illinois, has failed to meet the expectations of its projectors, but a factory in California is now in successful operation. It will be a public benefit to have beet-sugar factories in operation all over our country, and it is only a question of time when the work shall be set in operation.

To those who may wish to look further into the subject, I may mention that one of the Paris Exposition Reports, published by the State Department of the United States, contains a very full description of the process. A series of articles upon the subject was printed in the *Scientific American* in 1869, and the same articles, with some additional matter, estimates of costs, profits, &c., have been printed in a book entitled "On the Manufacture of Beet Root Sugar in England and Ireland, by William Crookes, London, 1870." A quite full

report can also be found in the report from the Department of Agriculture for 1869.

The Report of the Department of Agriculture for October, 1871, says the Alvarado (California) Beet Sugar Company are again manufacturing sugar. Their supply this year will reach 8,000 tons—16 tons to the acre. The amount of sugar made last year was 500,000 pounds. This year it is expected to reach 1,125,000 pounds, and to employ the mill about five months. The Sacramento Company will soon be ready for operations.

The institution for the education of farmers and those interested in agriculture were visited, and many valuable and interesting hints and suggestions in relation to the subject were obtained. But it is scarcely necessary to repeat them here, as I have already printed the result of these observations in the Agricultural College Report for 1870. I should not, however, fail to remark that the education for farmers, who are to exert the most influence for their calling, differs but little from that required for any other active pursuit in life. The elements of literature and the principles of science are necessary for all; they lie at the very foundation of all education. The farmer may find a practical application for the principles of chemistry and physics more frequently than is done by those occupied with many other of the arts. But these may become the subject of special study after the general course is completed. For example, it would be a grand addition to the education of the farmer if he were chemist enough to judge of the purity of the fertilizers he buys. For success in farming every one is now obliged to buy artificial manures of some kind or other. No one can hope to keep up a good farm except by putting on fertilizers. And as these are liable to adulteration, and are grossly adulterated, the only safety for the farmer is in knowing the quality of his fertilizer and being able to detect the fraud. In this respect the farmers of Europe are far in advance of us. They have arranged their plans so that they can purchase with confidence—sure that the article they buy will be worth its cost. Their super-phosphates, their ammoniacal manures and their potash are rated in value by the amount of pure material they contain, and the vender is liable to prosecution if his articles are not up to the standard. With a greater number of educated farmers, and larger demands for fertilizers, it is to be hoped that we too shall come to the same honest way of dealing.

There are many curious circumstances connected with the farming people of the countries we visited, but nowhere do they enjoy the same comforts that they do with us. The price of labor is low, scarcely half as much as with us, the prices of good bread and meat are as high as ours, or even higher, the price of land is extravagantly high, and everything is arranged so as to scarcely afford any hope of advancement for the working man. We may see many things which would be useful to us in their modes of practice and use

of capital, but we return again to our own country with thankfulness that our lot is cast in a land where men are worth more than money or lands, where every man may own a home of his own, and where, with free education for all, the poorest citizen has all the avenues to comfort, to independence and influence as open to him and his children as they are to the richest in the land.

APPENDIX C.

REPORT OF THE AGRICULTURAL COLLEGE FARM.

LOCATION.

The farm is a mile and a half from Rutgers College, and from the New Jersey Railroad depot. It lies on the south end of the city, while the college and the railroad depot are at the north end, so that most of the distance is through paved streets. Strangers desiring to visit the farm will find the most direct route to be along George street about a mile to Nicol avenue, and thence along the latter thirty or forty rods to the farm entrance on the left.

SIZE AND DIVISIONS.

The farm contains ninety-nine acres, and is much longer than it is wide, its extreme length being only eight rods less than a mile. The houses and other buildings are near the entrance, and twenty acres near the buildings are kept in grass or used for garden, soiling and root crops. The remainder of the farm is intended to be kept in Indian corn, potatoes and oats, wheat and clover and timothy. The whole is to be cultivated, and no permanent pasture, woodland, or waste ground allowed upon it.

IMPROVEMENTS.

The last new ground upon the farm, a plot of six acres, was plowed last year, but has not yet been cropped. In the intervals of other work it has been underdrained and will be mostly cleared of stumps within the next month or two, and made ready to grow a crop of corn next season. The whole farm will then be in use, though not by any means in condition to yield heavy crops; the soil was naturally too cold, wet and poor to yield heavy crops without repeated tillage and enriching. Two hundred and four rods of tile drain have been laid—all the tile being round, and the different pieces joined to each other by collars. From the extremely level surface of the ground, it is difficult to secure sufficient depth of ditches, and adequate fall, for good drainage. One ditch, some forty rods long, was dug four feet deep, and with sufficient fall; it works

admirably, thoroughly draining the water from the surface, and leaving the ground so dry that a heavy crop of corn was grown—where, last year, the ground was covered with water much of the season, and nothing but rushes and bog-grass grew.

CROPS.

Wheat.—Six acres were in wheat, and the yield was two hundred and two bushels, or, about thirty-three bushels to the acre. The ground was in potatoes last year, and well manured with a compost of barn yard manure and marl. No manure was used with the wheat. A half acre of the field was sown with Tappahannock, the rest with the ordinary red wheat. It was sown broadcast about the 28th of September, and was harrowed in and rolled. The yield of the white wheat was only fourteen bushels, or twenty-eight bushels per acre—not nearly as large as the red, though it was on better ground. This is the third season we have tried it, and, as it has not done well in any, we do not propose to sow any more. When the farm was purchased, this field was almost divided by a rough gully and swale which was covered with bushes and trees, and one side was broken by an old deeply gullied lane, with wide hedge-rows on the sides. The portion cultivated, which was as good as any on the farm, was planted with field beans, but the crop did not pay for gathering; and the root crop which preceded the potatoes was a failure.

Indian Corn.—Two fields of corn have been cultivated; one of about ten acres, and the other of nine. The first is at the extreme rear end of the farm; had never been cropped before, and had but lately been reclaimed from a flat and swampy wood lot. A part of the ground was plowed three years ago, dressed with gas lime, and sowed to rye and clover, which were pastured off; a part had never been plowed before the autumn of 1870. The field was underdrained last spring, plowed, dressed with a compost of marl, stable manure and hair, and planted May 12th and 13th. The corn grew well, and the crop is seven hundred and fifty bushels of ears. The second field is one on which we had oats last year, and intended for meadow, but the timothy and clover were killed by drought, and late this season we had to plow it up for corn. The dry weather kept the seed from sprouting, and the growth was uneven and late. The ground was in medium condition for richness, and was dressed lightly with the same compost as the other. The corn did not ripen perfectly, and is not very hard. We shall have about eight hundred and twenty bushels of ears—planted the 20th of May.

Oats.—About eleven acres of last year's corn ground was in oats. The ground was new, two crops being all that had ever been grown on it before. It was plowed deep last fall, hoping to deepen the soil, and this spring it was sown early without further plowing or manuring. The crop started very finely, but the extreme dry weather of

May and June damaged it badly. Three acres were in Surprise, and the rest in Norway oats. We had one hundred and two measured bushels of the former, and two hundred and ninety-one of the latter. The Surprise oats is very handsome, but it does not stand up well; the Norway oats is much stiffer in the straw. The ground was evidently rich enough to raise the crop, but the cultivation and the season were both against it.

Barley.—About an acre of barley was sown on the same field, but it was a total failure, and not worth harvesting.

Potatoes.—Six acres were planted in potatoes. The ground was in carrots, beets, turnips and cabbage last year, and was in good condition; was plowed in the fall, lightly dressed with barn yard manure during the winter, plowed again, and planted to potatoes April 12th. The seed was cut, and dropped about eighteen inches apart in every third furrow, and plowed in. The vines looked well all the season, and the potatoes ripened early.

Three and one-half acres of Early Mohawks yielded two hundred and twenty bushels, or sixty-three bushels an acre. This variety is as early as the Early Rose, and of uniform and good size. The quality is excellent, though most persons prefer the Early Rose. It did not yield well with us last year or this, and we shall only try a few next year, planting them much closer than heretofore.

One and a quarter acres were planted with Early Rose potatoes, and the crop was one hundred and ninety-two bushels, or one hundred and fifty-four bushels an acre. This variety is well known, and finds a very ready sale. It is one of the best for cultivation.

One acre was planted with Early Goodrich potatoes, and we gathered one hundred and forty-two bushels. We have raised this variety for a number of years, and it always yields well, and the potatoes are of good quality.

One-quarter of an acre was planted with the Peerless, and we harvested sixty-eight bushels, or two hundred and seventy-two an acre. The potatoes are white, large and smooth. In quality they are not equal to the Early Rose.

The Bovinia potato is a very prolific foreign potato, of poor quality, raised for feeding stock. I saw them in some fields in England, and the ground seemed full of them. It is said that eight hundred or nine hundred bushels have been raised on an acre. A few that I brought home were planted, and they grew well, but not more than one-third as large a crop as the Peerless, and the potatoes were very knotty and rough. I consider them worthless in this country.

The Race-horse potato was a very early English variety, cultivated for table use. Grown with us there was an extraordinary development of very short and slender vines, and an abundance of potatoes, none of which were much larger than quails' eggs. The potato is of no value in our soil or climate.

The yield of potatoes is small upon our farm, as it is in all our

immediate vicinity. Whether due to some peculiarity of the soil, or to defective cultivation, I do not know; but propose to try again with some different mode of manuring and tillage.

Hay.—Eighteen acres were in clover and timothy for mowing, nearly fourteen acres of which were in a field that has been but imperfectly cultivated and enriched. The remainder was on good ground that has been well cultivated and dressed with marl or superphosphate of lime. The crop was light, on account of the severe drought in May and June; but nearly all of it yielded a second crop that was as good as the first. The four acres mentioned have been mown now for two years, and twice in each year, and the whole ground is still thickly and completely set with clover, none of it appearing to die out, while the timothy is less than at first. The superphosphate of lime and the marl seem to promote the growth of clover in our soil to an extraordinary degree, and to be lasting in their effects, while ammoniacal manures are exhausted in a single year.

Pasture.—Only five acres have been devoted to pasture, and that is a lot of ground from which the light growth of wood was cut off in the winter of 1868. The ground was plowed and sowed to rye in the fall of 1869. The crop was top dressed with marl in the winter, and sown with clover in the spring, but was thin and unpromising. In the summer of 1870, the rye and the little clover which grew were pastured off by cattle. Without any further dressing, there has been a fine growth of clover this year, and it has supplied a great deal of pasture for our stock.

Carrots.—Two and a half acres of carrots have been raised this year. The ground was good, and was plowed deeply last fall. It was top dressed with barn yard manure in the winter, plowed twice in the spring, and top dressed, with four tons per acre, of a compost of hair, marl and manure, harrowed, and the carrots planted in drills twenty-eight inches apart, without further manuring. The variety cultivated was Bliss' Improved Long Orange. The carrots came up early, were carefully weeded, and thinned to about eight inches apart, and grew well. The crop was two thousand and fifty bushels, or a little over eight hundred bushels an acre.

Beets.—Five acres of ground have been in beets, and the crop amounts to two thousand six hundred and eighty bushels, or five hundred and twenty bushels to the acre. The ground was all tilled and manured alike, except that the top dressing of hair, marl and manure compost was not put on most of the beet ground. A quarter of an acre that had compost on it yielded two hundred and twenty bushels of Mangolds. The ground throughout was about equally rich, and the compost must have made the difference. That is, a dressing of manure worth, at most, $20 an acre, made a difference in the crop of three hundred bushels an acre, or a value of nearly $100. The varieties raised were the Long Red Mangold, Yellow Globe Mangold, Intermediate Yellow Mangold, Silesian Sugar Beet, and the

Nursery or Vilmorin Sugar Beet. The Intermediate Yellow Mangold yielded the largest crop, but all the varieties were good. The Silesian Sugar Beet was from seed procured at the sugar factory in Halle. The seed was planted on good ground, which had been dressed with the composted manure. From a quarter of an acre was taken one hundred and forty bushels of the beets. They were large, almost entirely under ground, and kept growing till the end of the season. An analysis shows them to contain——per cent. of sugar, which is about the same with those raised in countries where sugar is made from them. In 1869 the average per centage of sugar from all the beets worked in Germany was $8\frac{3}{10}$.

The Nursery Sugar Beet was from seed bought at Carter's, in England, and was said to be improved from the Vilmorin Beet of France. It was grown on poorer ground and without the compost. The fifth of an acre only yielded sixty bushels, which is nine tons per acre. The per centage of sugar in them was——.

Turnips.—Two acres and sixty hundreths of Ruta Bagas yielded seven hundred and ten bushels. Sixty-three one hundreths of an acre of Green Top Hybrid, a Scotch turnip, yielded one hundred and fifty bushels; and fifty-eight one hundreths of an acre of English Greystone turnips yielded two hundred and sixty bushels. The turnips were well put in and manured, and were very promising, but the soil was heavy, and a long and heavy rain storm kept water on them so long that many plants were killed, and all of them greatly damaged. Lighter and dryer land would have been much better for this crop.

Cabbage.—Three and a half acres of cabbage were cultivated. The ground was good, and the plants that continued healthy have grown finely; but there was cabbage on part of the field two years ago, and now many plants were affected by disease of the roots and perished. The crop is not yet gathered, but it looks well. The market for them is very poor this year, and we should probably have done better with some other crop.

Sowed Corn.—Nearly two acres of sowed corn have been grown for soiling cattle. It was sown, broadcast, on ground that was in good condition and well manured. The growth was very rank and heavy, and a large amount of fodder for the cows has been obtained from this small plot.

Spinach.—This vegetable was grown to a small extent, and yielded a moderate crop. It will be tried again, and we hope with more decided success.

Fertilizers.—A large quantity of manure has been collected from the stock in the barn yard and stables. All litter, straw, &c., that could be collected on the farm, has been used to increase the amount. Twenty-six loads of manure have been bought in town and hauled out. One hundred tons of the Squankum and Freehold marl have been used in our compost heap. Fifty tons of hair from the glue

makers have been purchased. A compost of the hair and marl, with stable dung, has proved valuable, showing very marked effects on every crop on which it has been used.

We have also used eight hundred pounds of bone dust from Peter Cooper's glue factory, and eight hundred pounds of Russel Coe's superphosphate. These last have been put each on two measured acres of wheat for the purpose of observing their effects upon the grain and succeeding hay crop. For comparison with these, we have another plot of one and a half acres of wheat manured with spoiled linseed cake, about half a ton to the acre, and then a much larger area manured from the barn yard.

IMPLEMENTS.

For plowing in ordinary soil, our workmen all prefer the Collins steel plow, and we use it for all purposes. The Holbrook plow, for deep plowing and thorough pulverization of the soil, answers an admirable purpose, and we found large use for it last autumn and winter in our fall plowing, for which purpose I think it unrivalled. Holbrook's seed drill is an excellent and reliable implement, as we found in using it for all our root crops. Nishwitz's pulverizing harrow has been tried, and does its work well and easily. The soil is left in the finest state of tilth, and no sods or tufts of grass are turned over in its course.

STOCK.

The work of the farm is done by one pair of horses and one of mules. There will be work for another pair when the land is brought to its full measure of production.

The cattle consist mainly of cows, kept for supplying milk for market. It is the intention to have a thorough trial of Ayrshire cattle, which, for their weight, are said to yield more milk than any other breed. There are, on the farm, six cows and six heifers of this, and eight cows of other breeds.

The daily yield of milk of each cow is measured once in each fortnight, and the average is made from that. The following tabular statement shows the record of milk given by each cow, in quarts:

NAMES.	1870. November	December.	1871. January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Total.	Daily average.	Weight. Pounds.
1. Belle.					1–26	450	527	405	418	434	390	310	2934	10.1	1005
2. Grisette.	210	232	217	84	1	12 234	496	390	341	356	345	310	3216	8.8	905
3. Nelly.	345	356	325	238	139	15 45		10 320	465	449	434	434	3550	9.7	926
4. Netty.	375	387	294	239	155	90	1	19 154	465	449	405	372	3295	9	930
5. Mag.	345	356	372	322	263	165	1		7 384	480	480	449	3616	9.9	982
6. Rose.	330	341	279	266	248	225	233	180	77	1	18 222	558	2959	8.1	965
7. Fanny.		1 345	345	322	279	270	310	240	156	77			2344		
8. C.				23 75	465	420	465	420	435				2280		
9. N. J.						19 176	558	435	387	356	375	310	2597		1023
10. Bergen.	225	232	248	322	325	300	325	285	170	1–18 169	435	418	3454	9.4	1100
11. Bess.	300	310	263	252	248	180	21 108	9 309	449	449	434	372	3674	10.1	1020
12. Julia.	255	263	217	196	165	90	1–19 99	270	279	310	120	186	2450	6.7	960
13. Tolan.	225	232	186	126	124	105							998		
14. Martin.	144	372	372	312	341	330	325	285	186	77	17 60	28	2804	7.7	1030

The cows from No. 1–7 are Ayrshires; 8 and 9 are Durhams, imported last year, and not yet recovered from their voyage. 10–14 are native cows.

The small figures give the dates of drying—of calving.

No. 1 suckled calves part of the year. No. 2 is a three year old heifer. No. 7 is sold. Nos. 9 and 10 are selected from a number of cows, after trial. The Ayrshires are such as we have been able to get, and not above the average of the breed. The six Ayrshires average, for every day of the year, nine and two-tenths quarts. The four native cows average eight and four-tenths quarts for each day.

DONATIONS.

Seventy tons of marl have been received from the Squankum and Freehold Marl Company.

Eight hundred pounds of super-phosphate of lime have been presented by Russel Coe, of Linden.

A barrel of the Grafton Fertilizer was given by the manufacturers, through R. H. Allen & Co., of New York.

A hundred weight of *Soluble Phospho-Silicates* have been received from Dezeng & Co., Poughkeepsie, N. Y.

Nishwitz's harrow was obtained from the manufacturers, the New York Plow Company, Beekman Street, New York, at one-half the retail price, which is $30.

Two bushels of Fultz wheat were received from the United States

Department of Agriculture, and sown upon the farm, for the trial of a new, and what is hoped will prove a hardy and prolific variety of this important cereal.

USES OF THE FARM.

The experiments with fertilizers, the root crops, the stock, and the extensive series of under-drains, are objects of interest, and are being made the means of instruction. Visitors from different parts of the State come to see the farm. The successes and the failures are freely shown to them, and every facility is given to enable them to understand its working.

Bringing poor or exhausted land into high cultivation is slow and expensive. Almost every field which has been tilled has been a partial failure in the first crop, but with continued cultivation ever improves, and begins to yield paying crops.

The continued pressure upon all the laboring force of the farm, to make needed improvements in draining, clearing, and reclaiming waste land, has interfered somewhat with the regular work, and our records, on this account, are not as full as would be desired on a model farm, or for our own guidance in conducting further experiments; but we aim at making them fuller from year to year, and such as shall be useful to the farmers of New Jersey, and to the cause of improved agriculture.

APPENDIX D.

REPORT OF THE BOARD OF VISITORS.

To His Excellency, Theodore F. Randolph, Governor:

The Board of Visitors of the New Jersey State College for Agriculture and Mechanic Arts, beg leave herewith to transmit the annual report required by law to be made by them:

The Board held its semi-annual meeting at the College Building in New Brunswick, December 20th, 1870, and at that time attended the examination of the classes and made an inspection of the buildings and accommodations.

The *First* Class, which graduates in 1871, were examined by Col. Kellogg in Bartlett's Mechanics, and by Professor Atherton in Political Economy, and by President Campbell in Moral Philosophy.

The *Second* Class, graduating 1872, were examined by Col. Kellogg in Church's Shades and Perspective, and exhibited at the same time specimens of their construction, by graphical methods, of the problems in this subject; they were examined also in Analytical Geometry by Professor Bowser, in Natural Philosophy by Professor Murray, in Railroad Curves by Professor Bowser, and in French by Professor Meyer.

The *Third* Class (1873) were examined in Physiology by Col. Kellogg, in French by Prof. Meyer, in Algebra by Professor Bowser, in Rhetoric by Professor Doolittle, in Geometry and Geometrical Draughting and Constructions by Mr. Hasbrouck, and exhibited the books of their work done in this latter branch.

The Board also witnessed the exercises of the battalion composed of the members of the State institution in military drill. They inspected the arms and the accoutrements furnished by the Quartermaster General of the State and found them well preserved in suitable racks, and sufficient provision made for their safe keeping.

The Board gave its approval at this meeting to the proposition that Dr. Cook, Professor of Agriculture in this institution, should prepare a report of his travels and investigations in Europe undertaken in the interests of agriculture, and that this report should be transmitted to the Legislature, and when printed be distributed

through the counties. The Board deemed that in so doing the interests of agriculture would be subserved, and the valuable results which Professor Cook had attained would be made useful to the farmers of the State.

The Board made its second semi-annual visit to the College on Thursday and Friday, March 30th and 31st. They attended the examinations of the classes in the subjects which they had been perusing during the past term, which it will not be necessary here to enumerate. On this occasion the Board attended these exercises during two days, in order to make their examination more thorough, and to give themselves an opportunity to witness more in detail the workings of the system in operation.

The Board desire to express in this report their cordial approval of the system of instruction now pursued in the College. The course of study has been in use in all essential particulars, the same as at present, since the organization of the institution. It has been tried by the best test, that of experience. The graduates of the institution have been, so far as the Board have been informed, of a very high character, and an unusually large proportion of them have already been able to prove the value of their training in responsible and honorable positions.

Modifications have been made in the course of study, as occasion required, and the standard of scholarship has been steadily advanced. One important modification has been adopted by the Board of Trustees and approved by this Board, which has only gone into practical operation at the opening of the present College year, in September, 1871.

The course of study has been extended to four years.

This was found absolutely necessary in order to complete, in a satisfactory manner the branches of study included in the course. Either a higher grade of preparation must be demanded or an additional year must be added in the College. As many of the students of this institution are prepared at the common schools of the State, and as it is not desirable to place its advantages beyond the reach of students from all localities, it has wisely been deemed expedient to retain the present moderate conditions of admission, and extend the course in College.

The Board report with satisfaction that a large addition to the educational facilities of the institution is being made by the Board of Trustees by the erection of a building named Geological Hall.

It will contain, besides the extensive collections of Rutgers College, large and completely equipped rooms for Analytical Chemistry, and for Mining and Metallurgy. The basement also will contain a room to be used as a room where the Military Superintendent will be able, with better facilities, to exercise the students in their military tactics.

It is hoped that before the close of the collegiate year these greatly improved accommodations will be ready for the use of the institution.

In closing their report the Board of Visitors deem it a duty as it is to them a great pleasure, to testify to the fidelity with which the Board of Trustees have aimed to carry out the will of the State in their management of this public institution. Under their wise and liberal policy the institution has become a great public benefit, opening a means of education to many of the sons of our State. The College farm has been improved and brought up from its originally depleted condition, until it is, as originally intended, a *model farm*, furnishing instructive lessons to those who visit it of the wisdom and economy of liberal and scientific culture. The Board therefore feel it a duty to say that in all particulars which have come to their knowledge, the compact made by the Board of Trustees has been faithfully and carefully fulfilled.

All of which is respectfully submitted.

WM. H. HENDRICKSON,

President.

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